
GOCE orbit predictions for SLR tracking

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European Space Research Institute
European Space Agency

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Technical
Workshop
2009

Metsovo
Greece

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GOCE orbit predictions

Along-track errors should not be much larger than 50m in order to enable daylight tracking by SLR. At the beginning of the mission this requirement was often not fulfilled

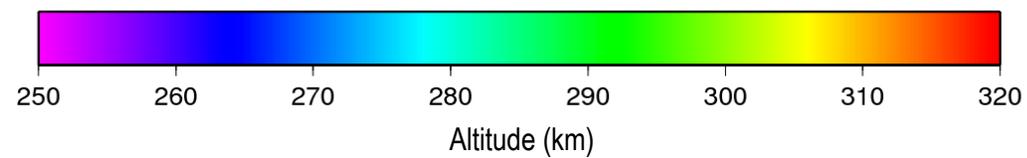
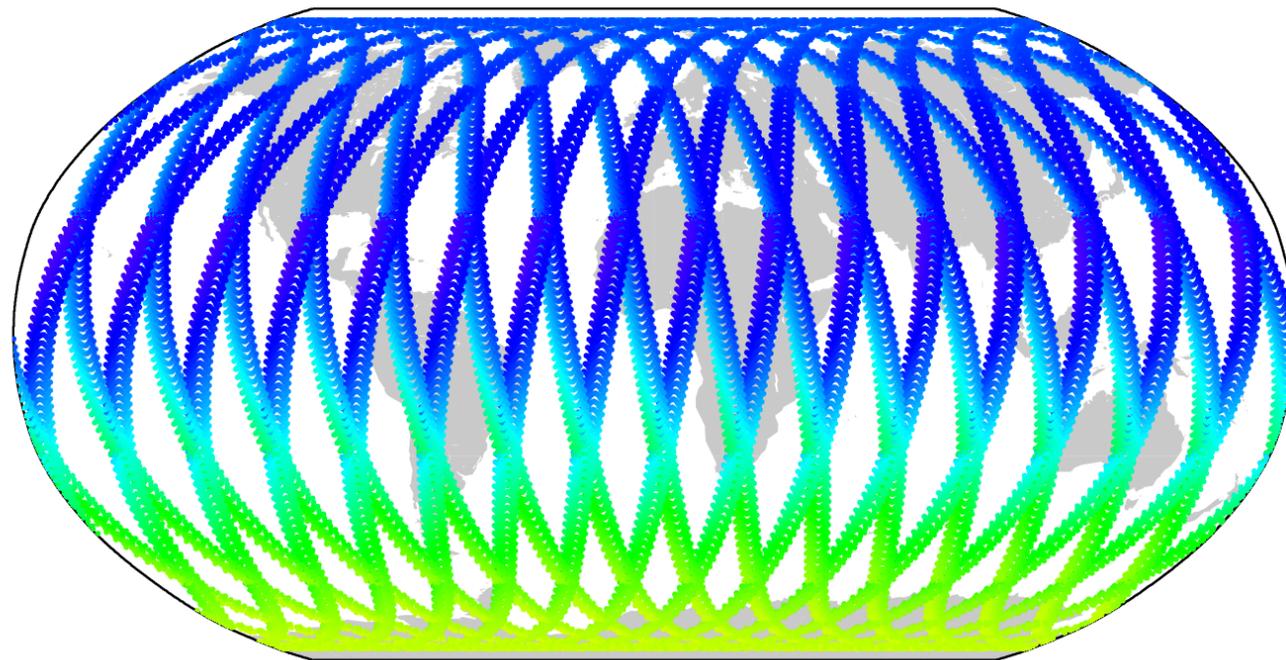
Tracking was thus restricted for quite some time to

- Yarragadee
- San Juan

→ Improved predictions were necessary

GOCE orbit

Begin of August, 2009



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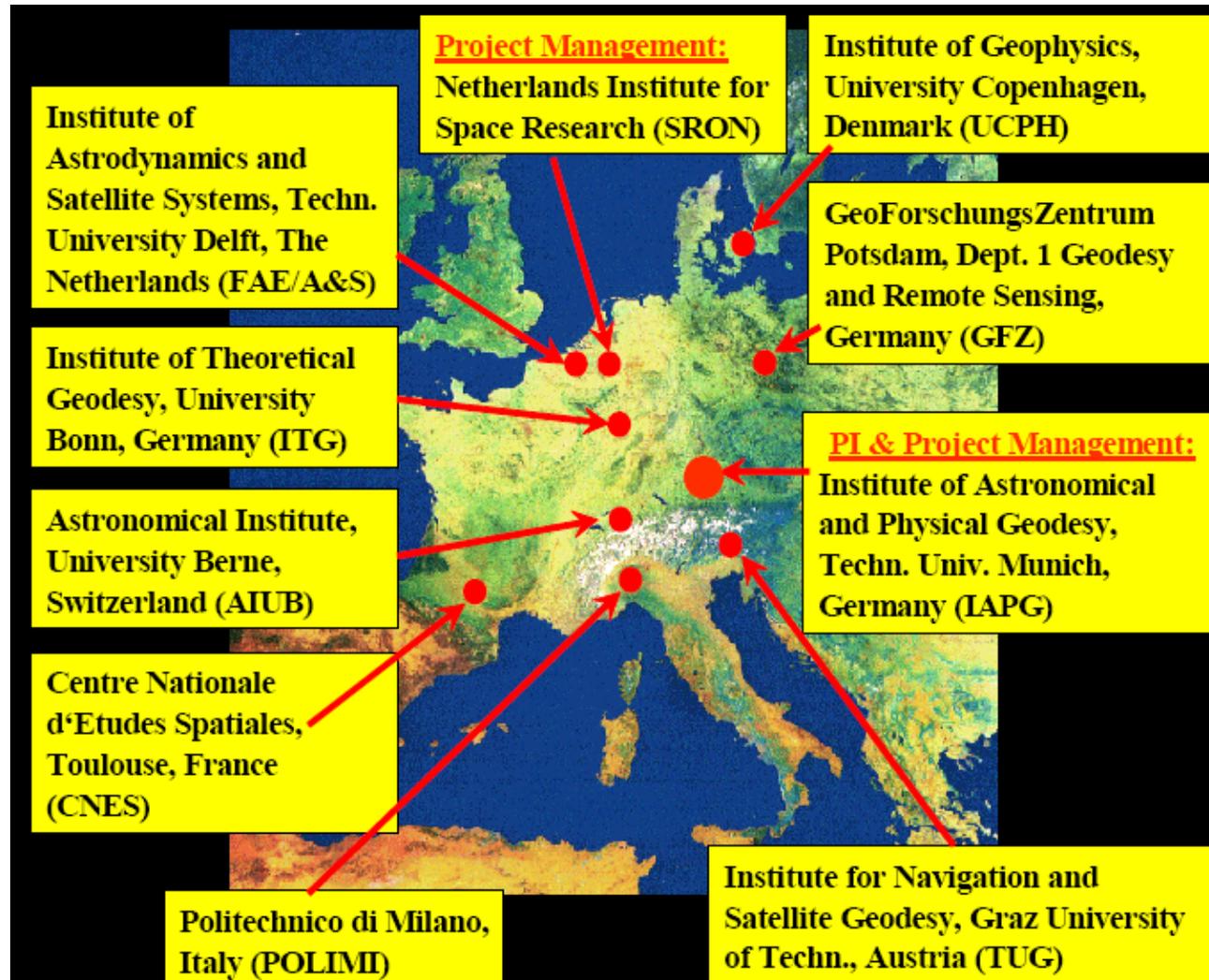
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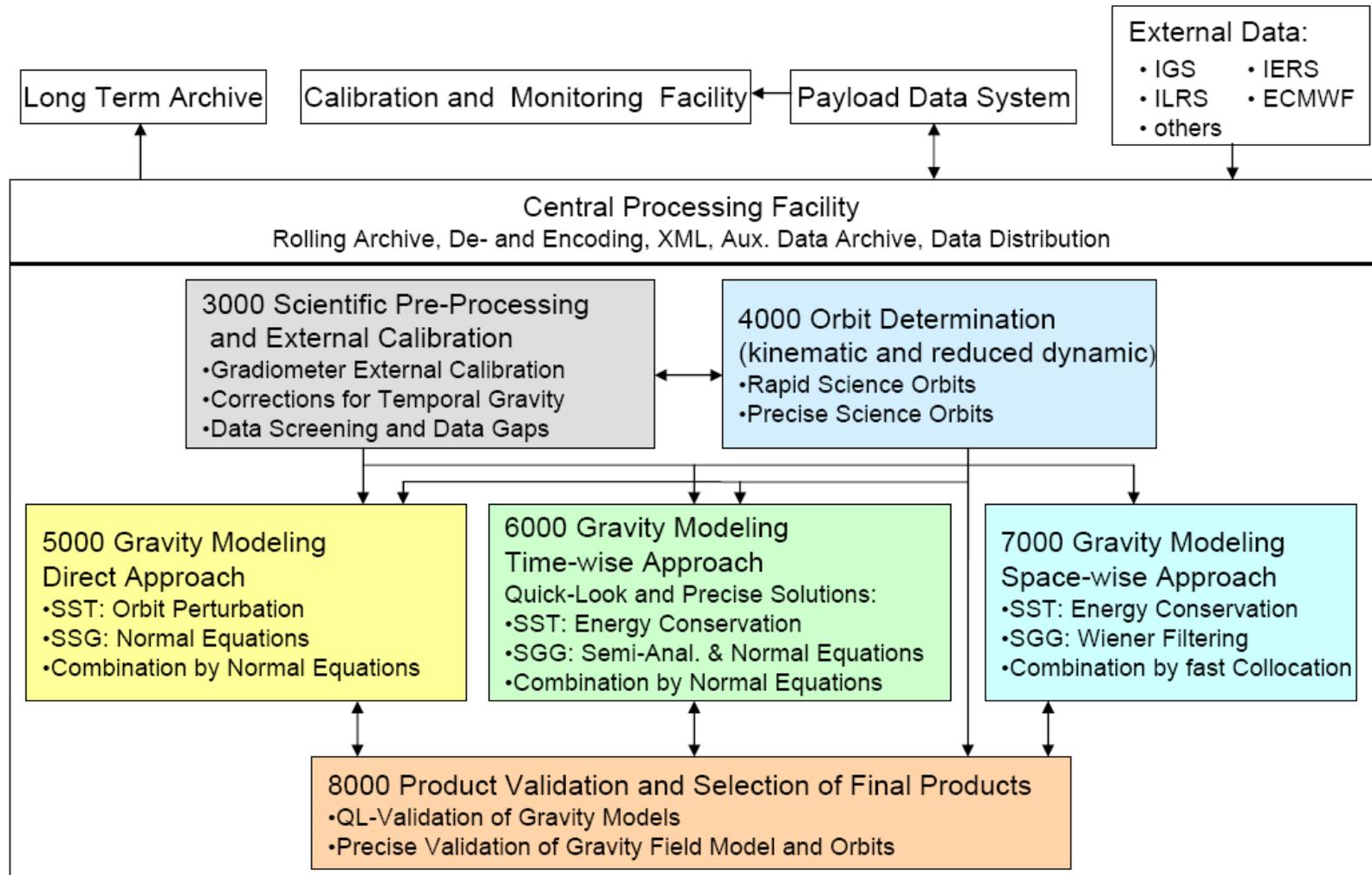
GOCE ground segment

High-level Processing Facility (HPF)



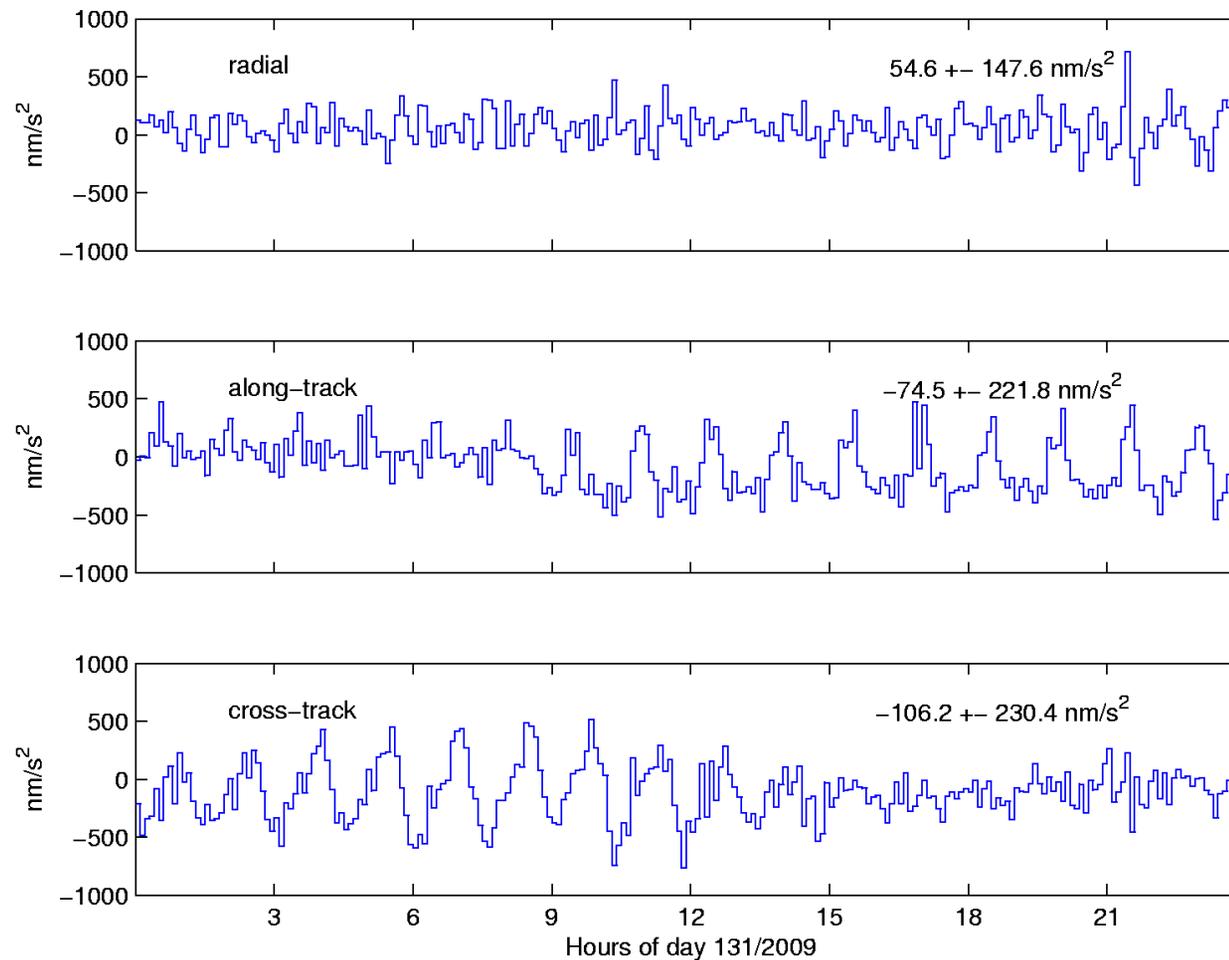
GOCE ground segment

High-level Processing Facility (HPF)



GOCE ground segment

Precise science orbit determination



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First drag-free flight on 7 May, 2009

Preliminary studies

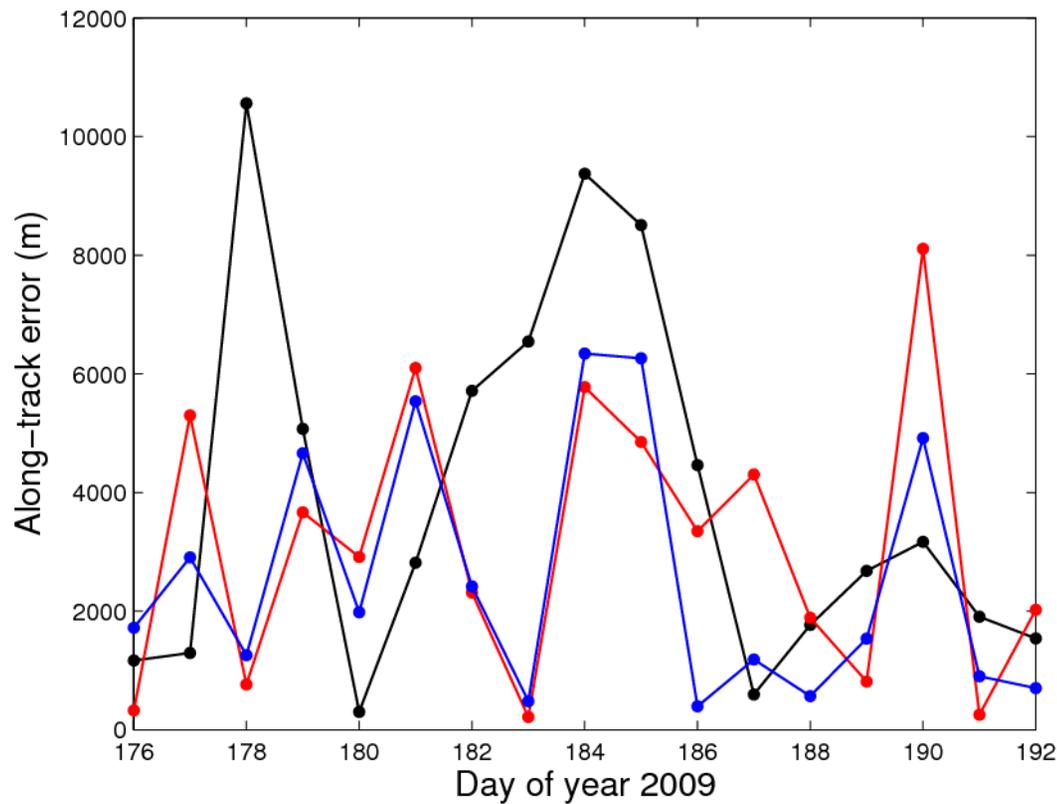
Predictions based on rapid products

- | | |
|----------------|-----------------------------------------------------------------------------------------------------------------------|
| GPS products | <ul style="list-style-type: none">• CODE rapid products (0h–24h UT)• Available ~ 7h UT |
| GOCE Data | <ul style="list-style-type: none">• GOCE GPS data (0h–24h UT)• Available ~ 10h UT |
| Observed part | <ul style="list-style-type: none">• Precise orbit determination using empirical accelerations over 6min |
| Predicted part | <ul style="list-style-type: none">• Extrapolation using different types of strategies |

Could be made available at ~ 10.5h UT

Preliminary studies

Quality of predictions



Strategy used:

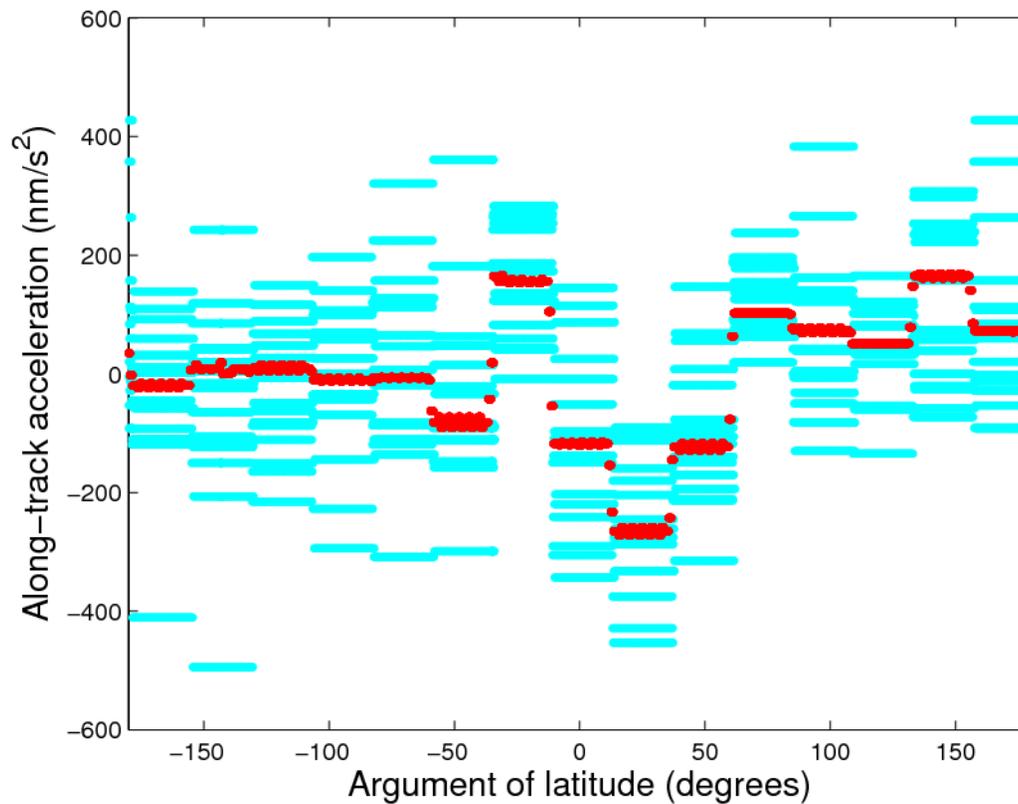
none

once-per-rev

empirical

Preliminary studies

Illustration of empirical strategy



Accelerations:

observed

mean

next day

Preliminary studies

Predictions based on 12h ultra-rapid

GPS products
(observed part)

- IGS ultra-rapid products (12h–12h UT)
- Available ~ 15h UT

GOCE Data

- GOCE GPS data (12h–12h UT)
- Available ~ 15.5h UT

Observed part

- Precise orbit determination using empirical accelerations over 6min

Predicted part

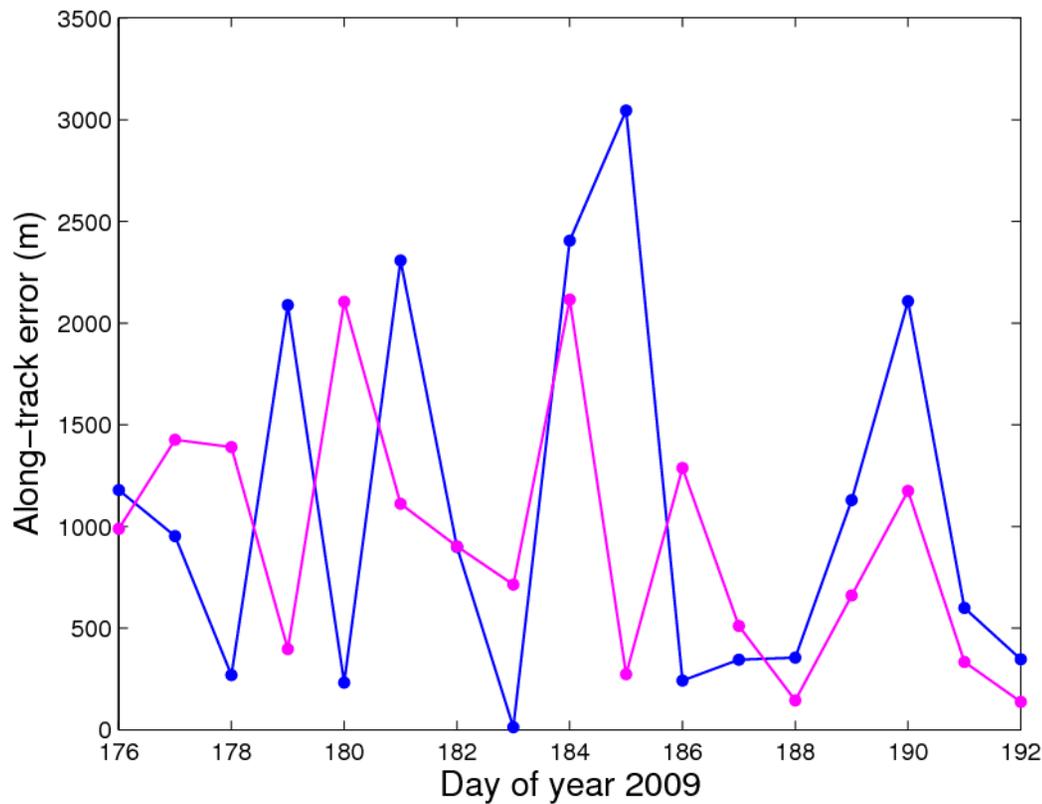
- Extrapolation using empirical accelerations from observed part

Could be made available at ~ 16h UT

Ideal for evening passes over Europe

Preliminary studies

Quality of predictions



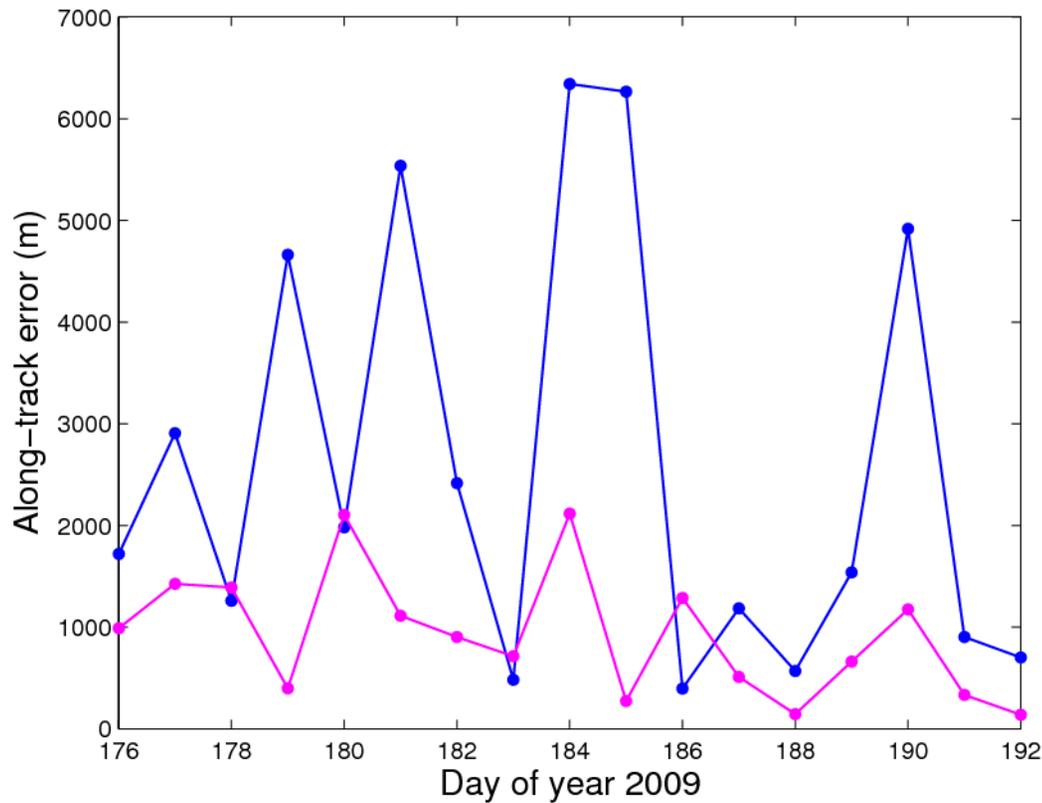
Orbits used:

rapid

ultra-rapid

Preliminary studies

Quality of predictions



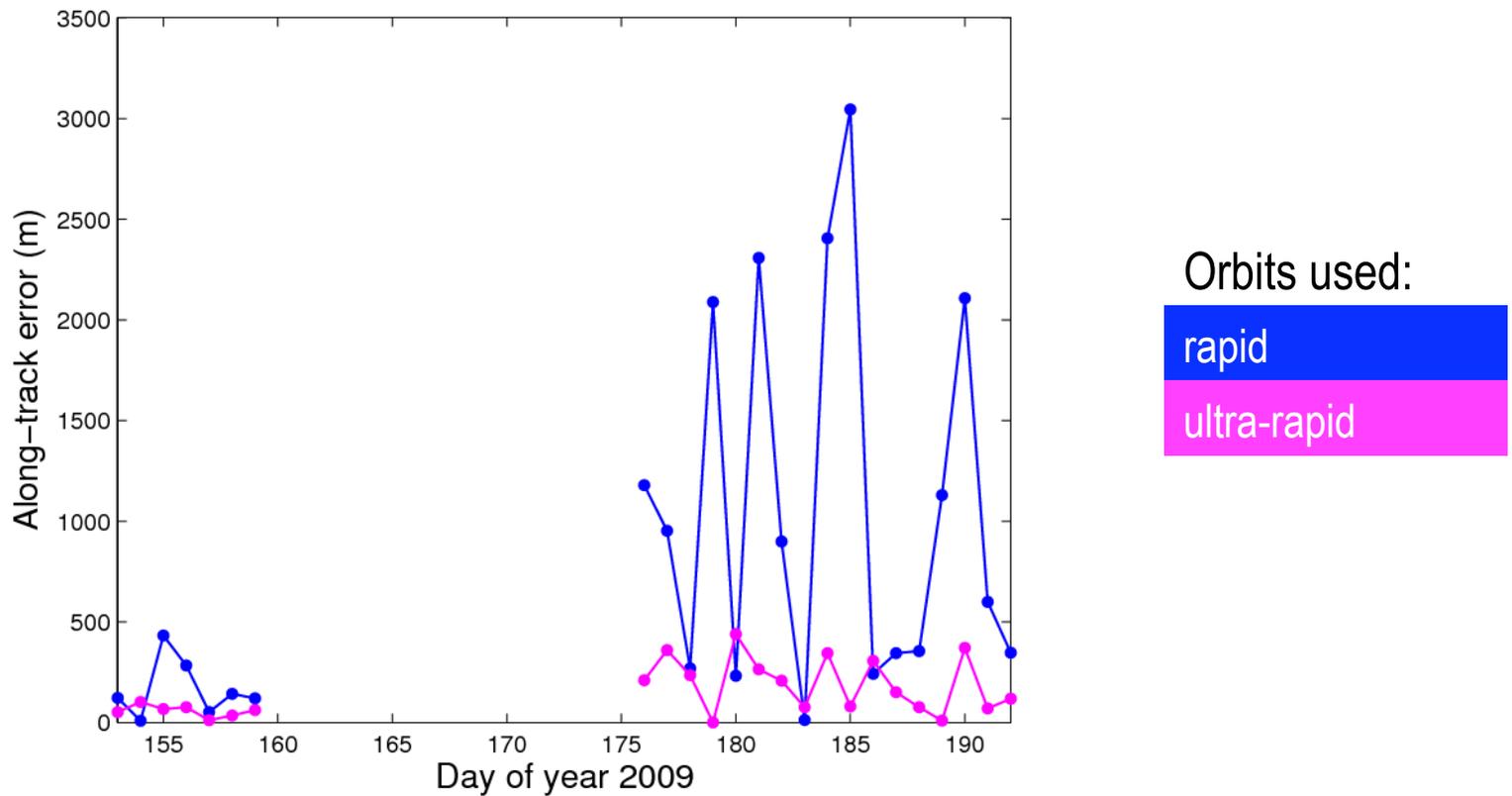
Orbits used:

rapid

ultra-rapid

Preliminary studies

Quality of predictions



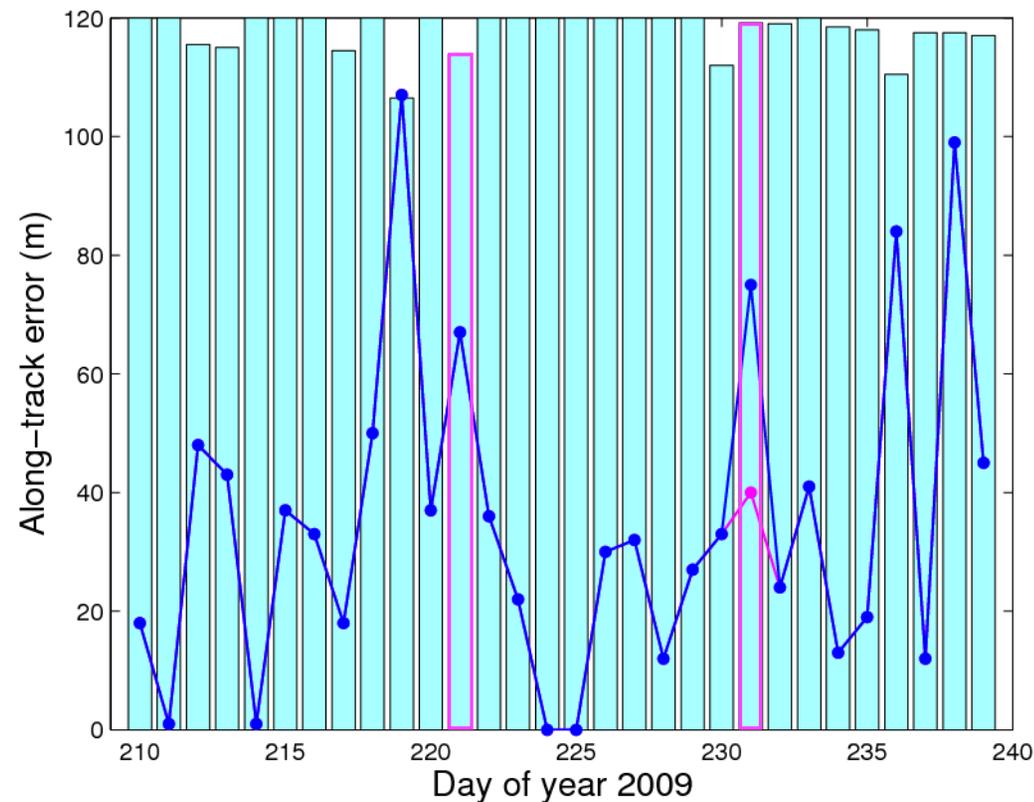
Orbits used:

rapid

ultra-rapid

Regular submissions

Quality of predictions at 17h UT



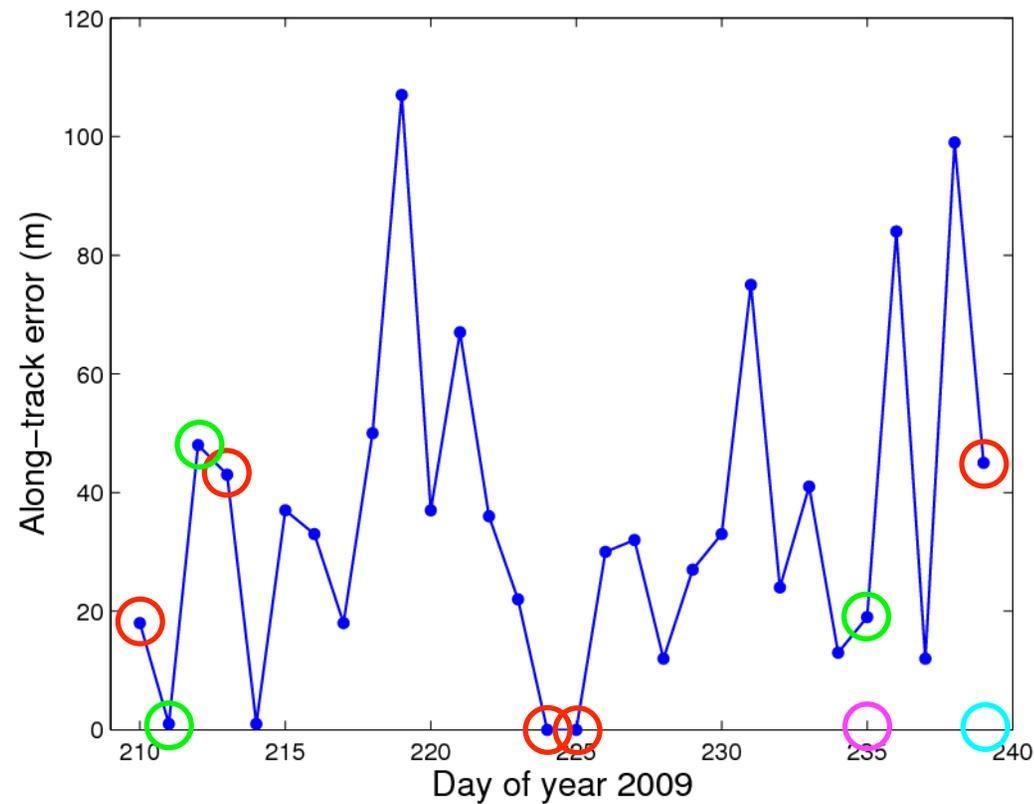
Predictions:

submitted

„mistakes“

Regular submissions

Impact of predictions on SLR tracking



Stations:

Zimmerwald

Herstmonceux

Potsdam

Graz

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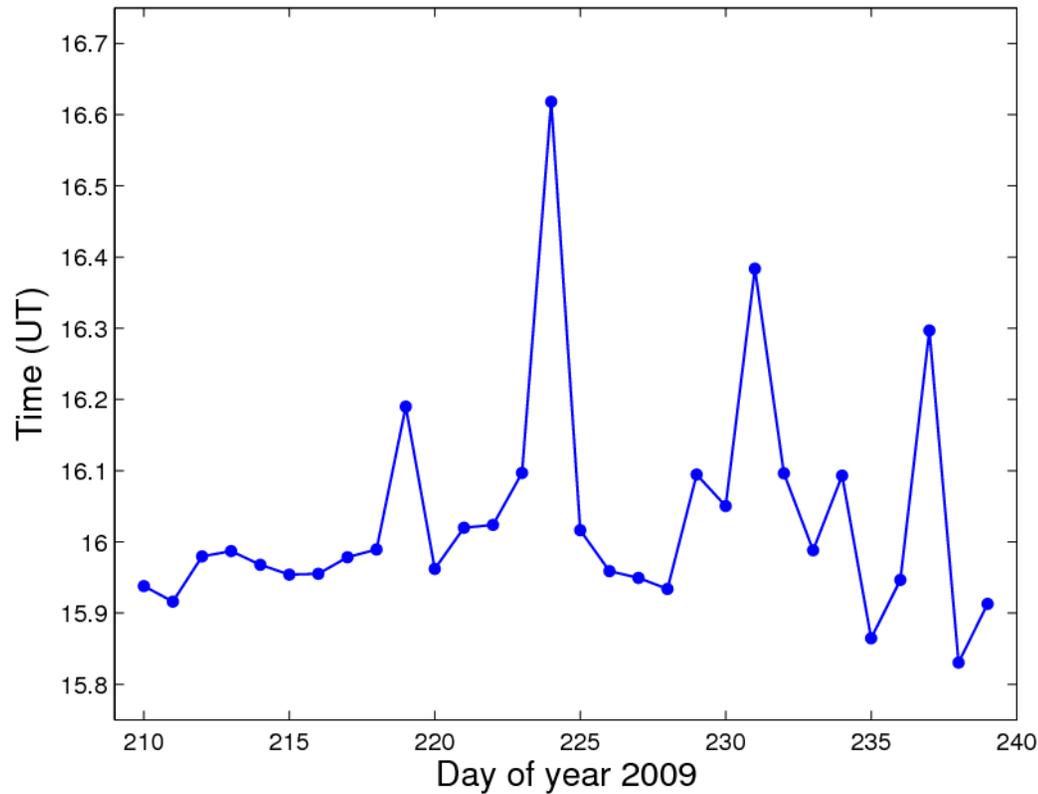
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Predictions enabled SLR tracking over Europe

Regular submissions

Availability of predictions



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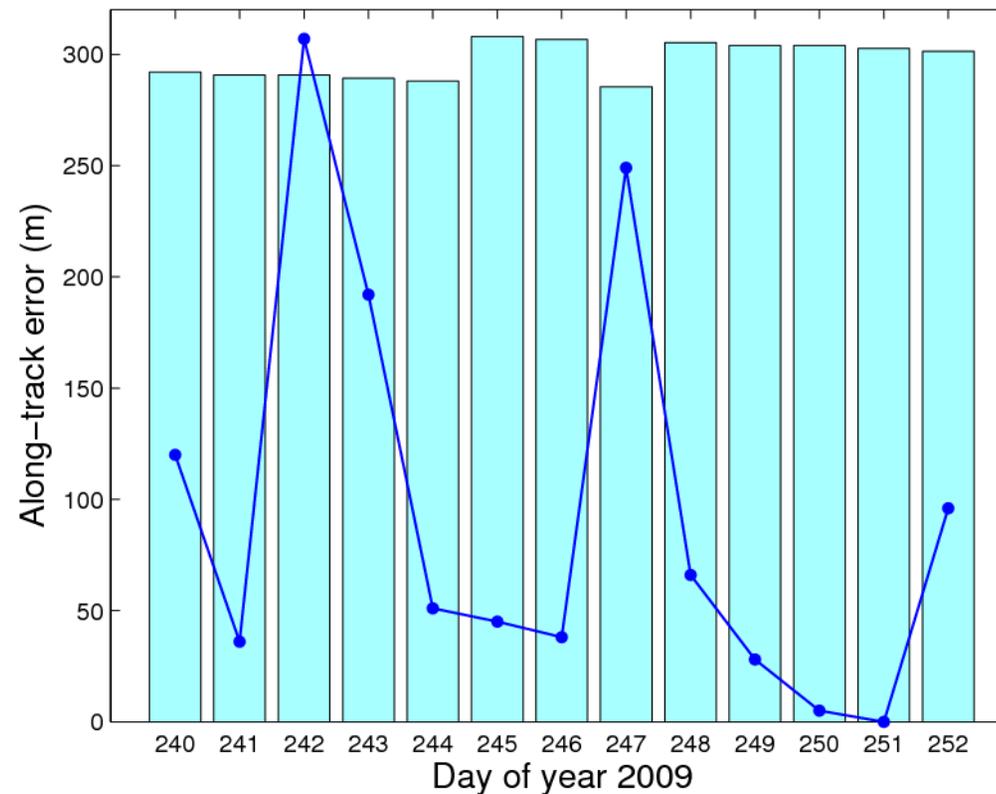
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GPS data availability and pass times dictate submission times

Regular submissions

Quality of predictions at 17h UT



Less data used since 28 Aug due to earlier pass times

Additional submissions

Predictions based on 18h ultra-rapid

GPS products
(observed part)

- IGS ultra-rapid products (18h–18h UT)
- Available ~ 21h UT

GOCE Data

- GOCE GPS data (18h–16h UT)
- Available ~ 21h UT

Observed part

- Precise orbit determination using empirical accelerations over 6min

Predicted part

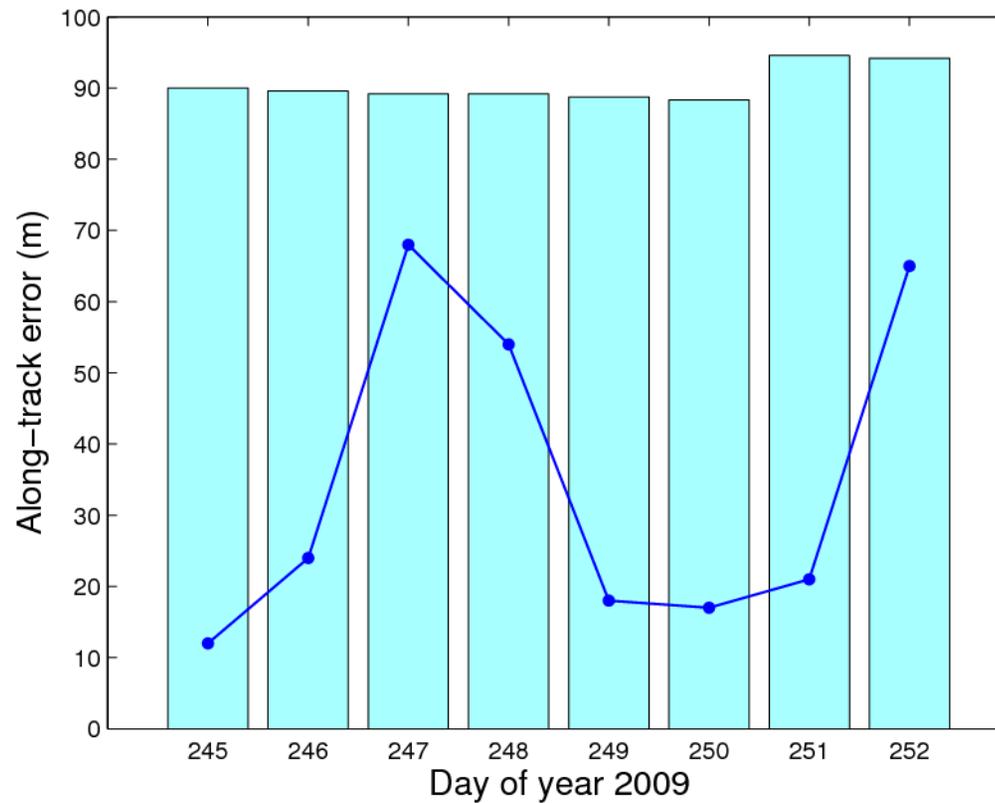
- Extrapolation using empirical accelerations from observed part

Could be made available at ~ 21.5h UT

Could improve tracking for other regions

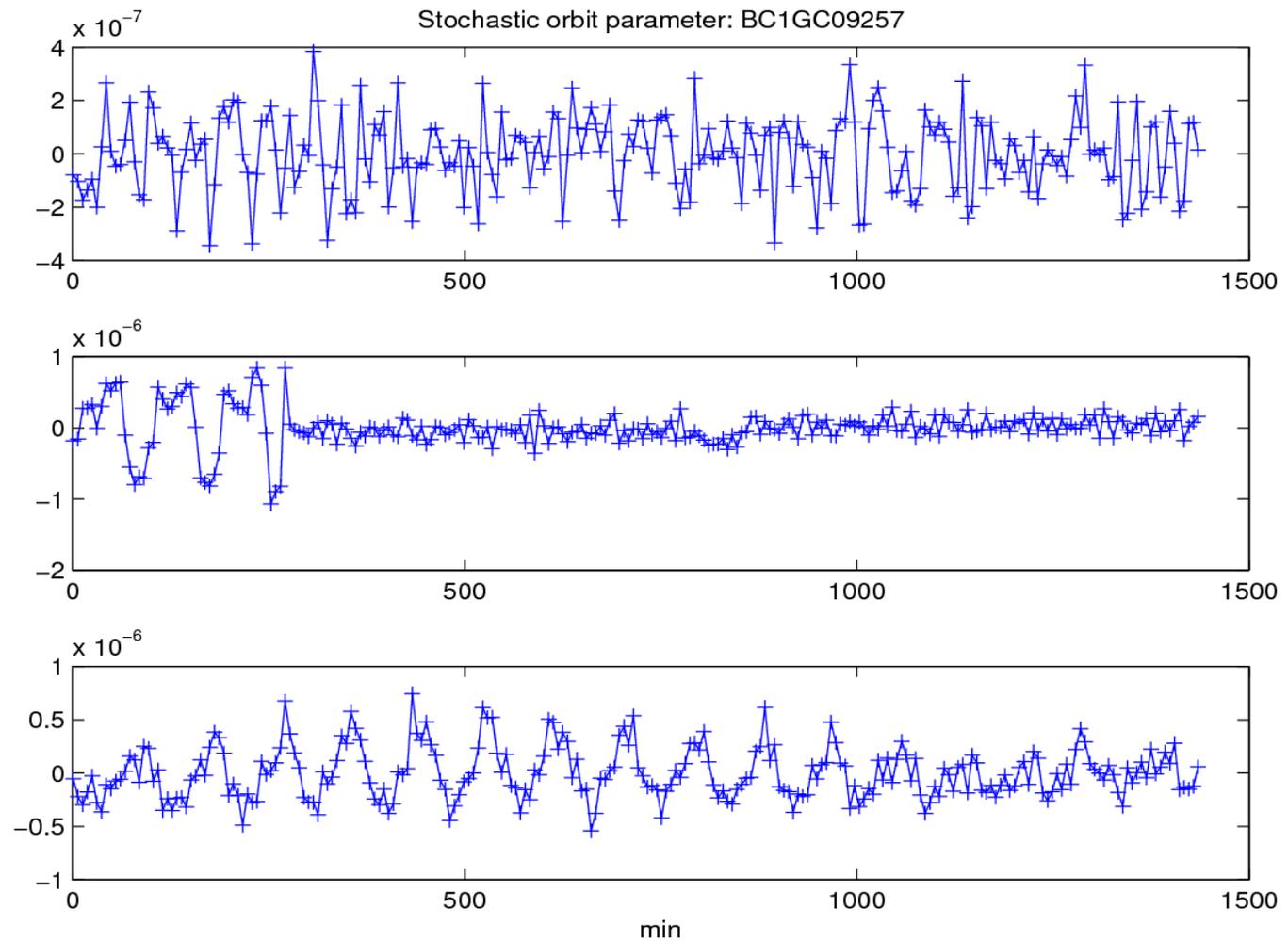
Additional submissions

Quality of predictions at 23h UT



Test solutions since 02 Sept, submissions will be started soon

GOCE orbit



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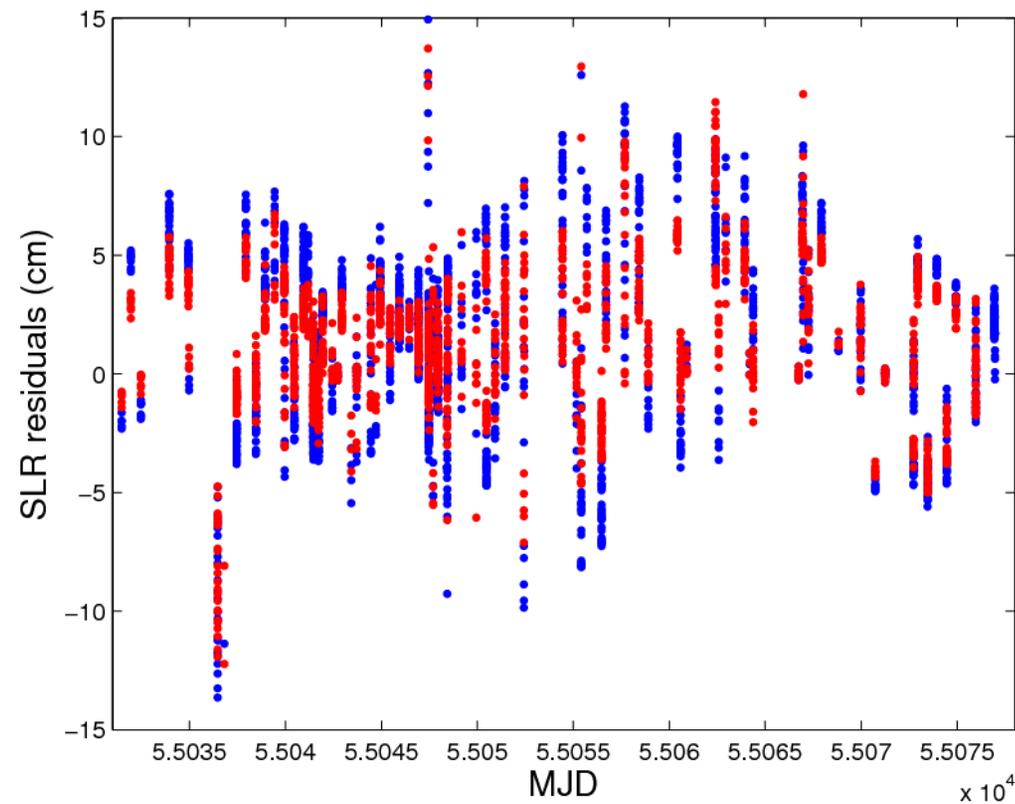
Drag-free flight has started again on 14 Sept, 2009

Conclusions

- GOCE orbit predictions enabled SLR tracking over Europe. Additional predictions will be submitted soon to improve the tracking for other regions as well
- Continuous SLR tracking is important (even in the commissioning phase) in order to calibrate the GPS-based GOCE precise orbits wrt. the
 - GPS antenna phase center offsets (PCOs)
 - GPS antenna phase center variations (PCVs)
 - orbit parametrization
 - ...

Conclusions

Orbit validation with SLR



PCVs used:

none

empirical

SLR residuals are indispensable for independent validation